Biochar Briquettes: Alternative to Firewood and Charcoal Fuel

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Outline

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Abstract

Domestic energy is an important component of our day to day lives and is something we cannot live without. Imagine how life would be without a means to cook our food, to warm our houses – life would be unbearable. As we enjoy these comforts rarely do we stop to think what the opportunity cost is. For those using renewable sources, it is not a big issue, but for those who rely on wood fuel, they have to strike a delicate balance between need for fuel and the need to conserve the greatest support systems of their livelihoods – the forests.

The main source of energy for households in many developing countries is biomass, mainly from forests and woodlands. The continued use of firewood and charcoal fuel puts a strain on forests, resulting in adverse effects on the environment such as prolonged droughts, loss of biodiversity, dwindling water resources, changing weather patterns among other sustainability challenges. An alternative to firewood to charcoal lies in biochar briquettes.

This paper discusses the role of biochar briquettes in mitigating climate change and serves as a step by step guide on how biochar briquettes may be produced.

Keywords: biochar, biomass, briquettes, charcoal, climate change, conservation, energy, environment, firewood, forests, fuel, leadership, sustainability

My Story

I have spent the last 20 years of my career in the field of Finance and Accounting and my view of the world has mainly been inclined to financial value creation. My narrative has been around shareholder wealth, return on investment, profit, and cost efficiency amongst other financial indicators. In that last three years, I have developed great interest in the area of sustainability and this has seen my narrative change – from the narrow economic view to a broader view that takes into account the society and the environment. The interest in sustainability has pushed me to seek more knowledge in sustainability leadership. The world is full of literature and ideas on what needs to be done to ensure that our world becomes sustainable, but there lacks the leadership to harness these ideas and to actualize them into tangible solutions.

As I was growing up – between the ages of seven and fourteen, I had to spend a lot of time mainly after school, Saturdays and during holidays and had to walk for long distances in search of firewood. Indeed if you take a closer look at my head, you will see the effects of carrying firewood with a rope strapped on my head. This practice still persists in some communities in my country, though at a lesser scale. Women and children especially, spend considerable amount of time fetching firewood and significant amounts of household budgets are spent on fuel such as charcoal and kerosene – thereby competing with other basic needs, while the long hours spent in fetching firewood could be spent on more value adding value adding social and economic activities. These are some of the experiences that propelled me into seeking to enact change, and the first opportunity to enact sustainable change is the same communities where I grew up.

What is Sustainability?

Sustainability means making the world work for everyone (AtKisson, 2013). Winston (2014) defines it as “ability to keep doing what you are doing”. While it might sound that simple, it is a big call to organizations, individuals, governments, business and every other entity to embrace new approaches in the pursuit of what they do on a day to day basis. You will not be able to continue what you do with a “business as usual” attitude, reason being that the world is not the same as it was a century ago. The world in Winston’s words is now hotter with scarcer

resources, and more open. In other words - a world characterized by significant climate change risks, continued depletion of resources and more enlightened and connected communities. The World Commission on Environment and Development (1987) gives a more encompassing definition of sustainability or sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The definition further emphasizes key pillars of sustainability as the environment's ability to meet present and future needs and progressive transformation of economy and society.

To ensure we have a sustainable world we need enact change in almost every aspect of our day to day lives – from the cars we drive, the food we eat, the fuel we use - the list is endless. When we think of change in the realm of sustainability, more often than not we think too far beyond the local context. We are encouraged to think globally and act locally. Winston (2014) suggests that we need to pursue a deeper level of innovation that challenges our own-held beliefs of how things work. He calls this heretical innovation “to capture this idea of exploring what we take for granted”. If you look around you, you will see many things we take for granted. In the communities around me, we have taken the providence of forests for granted for too long and it is time we used innovations like biochar briquettes to help conserve the greatest support to our livelihoods – the forests. What is it that you take for granted in your surroundings and what innovations can you think about? Think about it and start making that change.

Biochar and Sustainability

What are biochar briquettes and how do they contribute to sustainability? The word biochar is made up of two words – bio which is about or involving life or living organisms, and char – which means to reduce to carbon by incomplete combustion. In more technical terms, biochar is the carbon-rich product that results when biomass is burned under oxygen-deprived conditions (Leach, Fairhead, Fraser, & Lehner, 2010), a process called pyrolysis. You can make biochar from a variety of biomass - mainly from agricultural waste such as rice husks, bagasse, coconut shells, waste from pruned plants, and shrubs. Most of these waste is left to rot in the farm or is burned to ashes. From now on, know that these forms of biomass are valuable resources that can be turned into fuel and help save a few trees and incrementally save forests.

Forests hold significant potential in contributing to sustainability through the socio-economic benefits and ecological services they provide to communities (Bullock, 2017). According to WWF (2017), there are 2 billion people who rely on forests for shelter, water, food and fuel; 13 million people employed directly and indirectly in forests and related industries and 300 million people living in forests. Forests also present part of the solution to climate change - one of the greatest threats to humankind. With deforestation and forest degradation representing up to 20% of global anthropogenic carbon dioxide emissions with a significant impact on climate change, reducing forest loss can have multiple benefits for ecosystems and people. The benefits include cutting greenhouse gas emissions, sequestering carbon, providing other ecosystems services, and maintaining intact, functioning forests that have the best chance of withstanding climate change (WWF, 2017).

There is need for urgency in conserving our forests if we have to mitigate the impacts of climate change. There is even more urgency in Kenya where demand for wood fuel is one of the key drivers of deforestation and land degradation (Ruuska, 2003) and where biomass is the main source of domestic energy for 82% of urban and 34% of rural households (KFS, 2013). Kenya is also likely to be one of the largest charcoal consumers globally in absolute and per capita terms (Bailis, 2009). The over-reliance on charcoal and firewood is likely to change with increased attention towards renewable sources such as solar, geothermal, wind and more environmental friendly energy sources such as liquefied petroleum gas. This is however not expected to happen in the short or medium term, neither is it likely to change significantly for the low income households. This is because they may not afford or may not have access to the more environmentally friendly alternatives and therefore the need for a solution within the reach of these local communities like the biochar briquettes.

The change from charcoal and firewood to biochar briquettes is not all about environmental conservation. The change also comes with social and economic benefits. The energy and cost efficiency properties of briquettes mean that households will spend relatively lower on fuel and will be able to channel the savings to other needs competing for the little resources of the target communities. These competing needs include food, shelter, education and health. Directing more resources into these needs helps improve the social wellbeing of the communities. The project offers opportunities for economic empowerment of communities

within which the project is implemented. Communities will be the source of labor in the production facilities, in production of biochar and in the distribution of the briquettes, thereby positively impacting their economic wellbeing.

My Initiative

Having given the background of the problem at hand, let me now take you through how I went about identifying and actualizing this change. For change to happen, there has to be an "inciting incident" either self-imposed or triggered by outside forces (Howell, 2018). Allow me to explain how the idea of biochar briquettes came about. I was on a visit of Nepal in Asia, on a program dubbed Grassroots Innovations for Sustainable Development. One of the innovations we were studying was the use of biochar as a way of enhancing soil productivity. I however encountered the use of biochar in making briquettes and it is this potential of biochar as a source of fuel that interested me most. I saw this as the savior to energy challenges among the low income communities in my country. These grassroots innovations further convinced me that we need not wait to implement mega sustainability projects to bring about change. The grassroots innovations when scaled will incrementally create global change.

Before embarking on any project, it is important to lay down the key aspects of project in form a project management plan. You need to define the scope of the project, the project deliverables, and key milestones; determine the human, time and financial resources and a have a plan to help manage risks associated with the project. You need tools that will enable you track the progress of the project, the milestones, the roles of the different team members (Tate & Martin, 2010). The Gantt charts and work-break-out schedules are some of the tools that we found very useful for this purpose.

Once a project plan is in place, you need to determine the vehicle within which to implement your initiative. Whether you are implementing it in your organization, or outside your organization, you need to create a shared vision with your project sponsor and the implementing team. This will ensure that the sponsor and the project team are "connected and bound together for a common aspiration" and to provide the focus and energy for learning (Senge, The Fifth Discipline: The Art & Practice of the Learning Organization, 2006). It wasn't very difficult to create a shared vision with my project sponsor Ecocare Africa. Their experience in

environmental consultancy and also their keenness to identify with a project that is delivering tangible sustainability solutions made it easy to create the shared vision. As you chose your project sponsor it is important to ensure there is a level of alignment between what they do and your initiative otherwise it might be difficult to create a shared vision.

Another important step is to create a vision for your initiative and a strategy. A vision sets a general direction and motivates employees towards that positive outcome, and the strategy defines how that goal will be accomplished (Weiss, 2011). We set out our vision as "Affordable, efficient and sustainable energy solutions for households and light industries in Africa". Our mission is "to develop and market affordable, efficient energy solutions for households and light industries in Africa that empower communities and conserve the environment using biochar technologies". We also came up with a set of strategic objectives that were specific, measureable, achievable, relevant and time bound (SMART). The objectives allowed us develop system level measures among them measures of revenues, costs, number of customers using briquettes, quantities of materials used in and related output. Hazy (2006) as cited by Metcalf & Benn (2012) argues that leadership effectiveness in complex systems is best measured through emergent system properties, rather than the more traditional measurements of individual behaviors. As you implement your initiative you need to identify what measures will help you determine the success of your initiative.

Stakeholder Analysis

In any project, you need to consider the stakeholders. Projects or businesses operate with and system that includes customers, its supply web, its shareholders, and increasingly, stakeholders who may not interact with the project in any way, but may have an impact or may be impacted by the project. You need to analyze the role of the various stakeholders in your initiative, the matters that are of concern to them, their legitimacy, influence and the necessity of their involvement (BSR, 2011). We found the model advanced by BSR Consulting (BSR, 2011) very helpful in analyzing and mapping the different stakeholders we identified. Our stakeholders included the local communities, the existing charcoal production and distribution network, environmental regulatory agencies and non-governmental organizations working on

conservation, suppliers of complimentary products such as energy saving stoves and other briquette manufacturers.

In addition to understanding your stakeholders so as to inform decisions in the implementation of the project, you need to identify stakeholders whose input will contribute to the success of your initiative. When implementing a project that involves change, you need stakeholders with whom you can form guiding coalitions - strong teams with a shared objective that are able to implement change far better than a single individual (Weiss, 2011). You may also need to collaborate with other like-minded organizations and even competitors to ensure you progress the common goals of your initiatives faster, share best practice, learn from other's success and failure, and also gain the benefit of strength in numbers when lobbying different audiences (Sarda). The need for a guiding coalition and collaboration in sustainability projects is further emphasized by Senge et al (2007) who note that meeting the sustainability challenge will require the kind of cross-sector collaboration co-created by various stakeholders. One group of stakeholders that we found to be very good allies were the manufacturers of energy saving stoves as they have the same vision as ours around energy efficiency but with a complementary product.

Project Feasibility

Once you have a project management plan and tools in place, have identified and factored stakeholder interest into your plan, you need to look around and understand the landscape within which you are implementing the project. You need to identify who else is producing briquettes in the market, what technology they are using, what their target market is, where they source their biomass and what risks and opportunities exist in the industry. An analysis of the strengths, weaknesses, opportunities and threats (SWOT) of your initiative will help identify the gaps, the blind spots as well as opportunities for improvement.

Our review of the briquette industry in Kenya revealed that briquettes making operations ranged from small scale community initiatives with no machinery to commercial operations using manual and electric extruder machines. The quantities produced were insignificant and were not noticeable in the market, neither were there visible initiatives to promote briquettes as an alternative to charcoal and firewood. They had challenges ranging from availability of biomass, availability of capital and lack of appropriate equipment to produce adequate quantities

and quality briquettes (Cohen & Marega, 2013). From this we concluded that there was immense opportunities in the market waiting to be exploited.

The technology to be used is particularly one that needs to be thought through. Due the capital intensive nature of technology, you need proper feasibility with regards to the initial and subsequent running costs of the machinery, availability of machinery and related spares. You may need to visit sites where such machinery is in use to satisfy yourself that it is capable providing the desired deliverables and whether it can be customized for your local setting. Our search for machinery took us to China where we saw the machinery in operation and were able to source and ensure that it was customized to our local needs.

The location of the production facility is equally important. Key considerations include availability of affordable land to set up the production facility, availability of labor, availability of biomass and accessibility to the markets. Considering that briquettes are targeted at low and middle income populations, the lower the costs of production, the more the product will appeal to the target audience. Easy access to the market will also ensure minimal costs in getting the product into the markets and related environmental impacts from emissions associated with transportation which might negate the sustainability objectives of your initiative. We chose to locate our production plant in Thika, Central Kenya for the reasons that it is home to large forests where shrubs, mainly invasive species can be harvested. There are also large tracks of abandoned land and vegetation along river banks and roadsides that is often cleared and left to dry. The area also has vast agricultural lands from where agricultural waste resulting from the pruning of coffee and tea is readily available as well as post-harvest waste from pineapple farms and nut processing factories. The area is also at close proximity to the biggest charcoal fuel market - the suburbs around Nairobi City.

Every project requires resources –from human resources, capital resources and for our case natural resources. Availability of these resources is largely tied to availability of financial resources. You need to be clear where your financial resources will come from. The sources could be shareholders, loans or grants. The way you position your project can open up opportunities for funding from impact investors who are actively placing capital in businesses and funds that generate social and/or environmental good (O'Neill, 2011). We believe our project would qualify for such funding but we initially funded from shareholders' funds. We however

have the intention of reaching out to development agencies and impact investors to enable us scale our project. We believe having started the project will go a long way in demonstrating salience, credibility and legitimacy - critical components when garnering for resources and collaborations (Basile, 2014).

The Briquette Making Process

The briquette production process starts with the production of biochar. The simplest way of doing this is using small homemade kilns (think of drum with a lid). Biomass is fed into an open kiln with open flame in small proportions in a manner that ensures minimal exposure to oxygen. Once the kiln is filled up, it is covered with a lid and the smallest of outlets sealed – mostly with clay - to ensure no oxygen gets into the kiln. After at least six hours of oxygen deprived combustion, the char would be ready for the next process. It is however advisable to leave the kiln undisturbed for a longer time – sometimes overnight to avert the risk of fire. This method of biochar production is only suitable for large-sized biomass such as shrubs, and woody biomass and yields small quantities of biochar. For large scale production and for carbonization of smaller size biomass such as saw dust, nut shells and rice husks, you need more sophisticated carbonization equipment.

To turn biochar into briquettes, you need a set of three basic equipment - a crusher or a hammer mill – to reduce the biochar into fine particles to ensure penetration of the binder; a roller mixer - for mixing the powder biochar with liquid binder; and a roller press machine that forms the mixture into briquettes of desired shape and size – a process called densification and which is achieved by forcing the particles together by applying mechanical force to create inter-particle bonding (Kaliyan & Morey , 2010). Other machinery that you may need depending on capacity and availability of capital include conveyors to move material from one equipment to another, a drying chamber and packaging equipment.

You need to decide what binder to use based on its availability and costs. Different binders that may be used include wood ash, cow dung, starch, clay, molasses and gum Arabic. We found starch powder to be the most suitable of the binders available in the market. The reason we chose starch was informed by studies of different binders including cow dung, wood

ash and starch in briquetting of sawdust, which showed that starch-bound briquettes produced higher calorific value (Muazu & Stegemann, 2017).

The next step in the production process is the drying of briquettes. You may opt to sun-dry the briquettes or use an electric drying chamber. This being a sustainability initiative, you may need to consider to which extent the use of electric energy for drying would negate the sustainability and cost efficiency objectives of your initiative. However, depending on the scale of production it may be necessary to have a drying chamber. Renewable energy sources should be explored. Our chamber was in the form of a simple green house similar to those used for agricultural purposes. Once dried to the desired levels, the briquettes are ready for use.

Makaa Safi

The success of any project is in ensuring the deliverables are availed and in line with the expectations of the customer and key stakeholders. Our deliverable was a product that we named *Makaa Safi* – Swahili for clean charcoal. Briquettes come in different sizes and shapes. Large scale users may require relatively large sized briquettes, while small scale or domestic users may require to use small sized briquettes that fit the size of the domestic stoves. We chose a size that is able to meet the needs of both sets of customers.

How you present the product to the customers is as important as the product. Packaging is an integral part of product branding and is the first point of visual interaction between the customer and the brand. The packaging therefore needs to be appealing enough to invite the customer to interact with the product. Another issue you need to consider is the quantities for the different packages keeping in mind the different needs and purchasing abilities of the target customers. Some domestic customers are only able to buy what they need for a day or two while commercial users such as hotels, schools some individual customers are able to afford large quantities. Our packages ranged from 50kg bag mainly targeted for heavy users to packages as small as 2kg bags. The 50kg quantities are packaged in reusable sacks, with the lesser quantities packaged in branded brown paper packaging.

How will your product reach the target customer? What distribution channels will you use? It would be quite expensive and unnecessary to create own distribution channels at the initial stages. Leveraging on existing channels is what worked for us. We identified selected

outlets, mainly gas stations, grocery stores and existing network of charcoal distributors. New channels emerged - mainly women and youth selling in open food markets.

Communication Plan

Putting the product in the market is not enough. You need to ensure that you communicate to your key audience for them to buy into your initiative. Kotter (2011) emphasizes the importance of constant communication and notes that under communication kills change. To be able to craft appropriate communication message and to create empathy in your audience, you need to understand your audiences "in a God-like way". You need to understand who they are and what they care about. You need to be able to classify the audiences using different audience persona categorizations, from example - "The Six Ways Americans View Global Warming" - the "alarmed", "concerned", "cautious", "disengaged", "doubtful" and "dismissive" (Hoffman, 2012), or the Adoption Curve Scale. Using the Adoption Curve Scale, we classified our audience as "Early Adaptors"- they are ready but careful about embracing change. The categorization as early adopters is driven by their quest to fulfil a need and not from a sustainability awareness perspective.

Understanding the persona of your audience enables you craft appropriate messages as well as helping determine the most appropriate medium of communication for the different audiences. Communication may be in the form of one-on-one engagement with your audience, through the use of traditional media or social media. For our communication we used local radio stations, social media and one to one engagements with customers at points of interactions such as grocery stores, gas stations, in open air food markets and social gatherings. We created short videos that we would share on social media channels mostly used by the target audiences such as Facebook and WhatsApp messaging.

As you craft the message, you need to frame your message in a way that appeals most to your audience. Our audience was more interested in cost and energy efficiency. Sustainability was not on their mind. Our primary message was about saving money with sustainability - saving the forests being the secondary message.

The Challenges

A successful project would not necessarily imply that it is not without challenges. Almost all projects encounter a challenge or another. The ability to overcome these challenges is important for the success of the project. You will face obstacles or antagonists who may not embrace your change or individuals and organizations standing on the way to thwart progress (Howell, 2018). An example of these are competitors. For our project these were existing charcoal producers and distributors – a big industry is big in Kenya, employing nearly 900,000 people in production and trade and estimated to contribute US$1.6 billion per year to Kenya's economy (Nyambane & Wanjiru, 2016). They were keen to maintain the status quo.

The other challenges could be blind spots arising from methods and assumptions that many not hold true and likely blur decision making. The challenges could also arise from gaps in full conceptualization of your initiative. You need to identify these gaps the soonest possible and find ways to overcome them to ensure they do not stand in the way of your initiative. One such challenge for us was the availability of biomass. While a variety of biomass such as rice, coffee husks and bagasse may be readily available, the kilns we are currently using are not appropriate for this type of biomass. As demand increases, we have identified the need to enhance the capacity of biochar production from a variety of sources by investing in high capacity carbonization equipment.

The Brand Promise

Brands need to have a bigger purpose beyond making money. You need to create a brand ideal by connecting the values the organization and the brand share with your customers (Howell, 2018). What purpose does your brand serve that will move your audience to action? Ecocare Africa values are about ensuring that we have a clean and safe environment for current and future generations. These values are brought out in the product name *Makaa Safi* and the tagline *Mazingira Safi.* This is Swahili for "clean charcoal", "clean environment". The reason we used the Swahili language was because it is the language most spoken in the country. The majority of our customers, being mainly in the low income suburbs and informal settlements mostly use this language in their business and social interactions.

The word “clean” is meant to bring out two meanings. The first one is the ordinary use which means being free from dirt. Charcoal is often associated with dirt and is often sold in backyards. We present briquettes as a cleaner alternative to charcoal. The packaging we adopted enables briquettes to be purchased from more cleaner and convenient locations including supermarkets. Charcoal may also result in accumulation of soot from excessive smoke which may result sooty cooking pans, sooty walls and ceilings as well as health risks associated with inhalation of excessive smoke. Depending on the biomass used and the effectiveness of carbonization, charcoal may result in unpleasant odors. Our processes are designed to ensure minimal smoke and unpleasant odors thereby promising cleaner cooking and healthier lifestyles.

The other meaning of clean, when used in the context energy refers to energy that is from renewable sources such as solar and wind energy. Depending on the sources of biomass and the process through which the briquettes are produced, coupled with the benefits to the environment, we are inclined to consider biochar briquettes as clean energy. We have structured our communication around conserving our environment and presenting the users of biochar briquettes as ambassadors of conservation and climate change mitigation champions.

End of the Road?

Having created a product, a brand and ensured that you have connected the values of your organization and the brand share with your customers, it is not the end of the road. You need to create a ritual around your brand that will ensure ritualistic use into customer engagements that they may continue using the product time and time again (Howell, 2018). Creation of a ritual is a gradual process that is achieved when the product is able to deliver the expectations of the customer and augmented by continuous communications to the target audience. For us it has to go beyond the product’s ability to meet the customers’ need for fuel to the sustainability outcomes. We will need to work to create awareness on the risks associated with forests depletion and once our audiences start appreciating their contribution to climate change and the small ways through which they can mitigate climate change, the ritual will start to emerge. As a starting point to creating the ritual we tied our brand to “humanity” and positioned our product and its customers as the savior of humanity by saving the forests, and then calling upon them to stand counted among those working to save humanity by saving forests.

For this project to have significant impact on the environment, society and economy, it needs to be scaled to national reach. This will require considerable amounts of resources to a scale where Ecocare Africa may not be able to sustain. The next stage will to seek collaborations with organizations that may be willing to collaborate in scaling the project. The challenges that the world is faced with today require systemic changes beyond the capabilities of individual organizations and thus will require partnerships with business, governments, investors, local communities and nongovernmental organizations (Albani & Henderson, 2014).

Finally, the biochar briquettes will not on their own present a total solution to fuel needs of the target communities. There is need to seek ways to further enhance the efficiency properties of briquettes by developing energy saving cook stoves. These communities also have other energy needs – the other most basic one being lighting. While the briquettes will serve the cooking and heating needs, opportunities exist for providing simple solar solutions which, with the briquettes solution will go towards creating comprehensive, affordable and sustainable solutions to the energy needs of the target communities.

It is definitely not the end of the road as "on the solution side, there are so many innovations that need to be diffused, so many great pilot projects that need to be scaled up, so many industries in search of transformation, and so many 'invisible sustainability' stories and case studies to be discovered - or created - and broadcast around the planet" (AtKisson, 2013). So what's your story? What is your innovation?

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